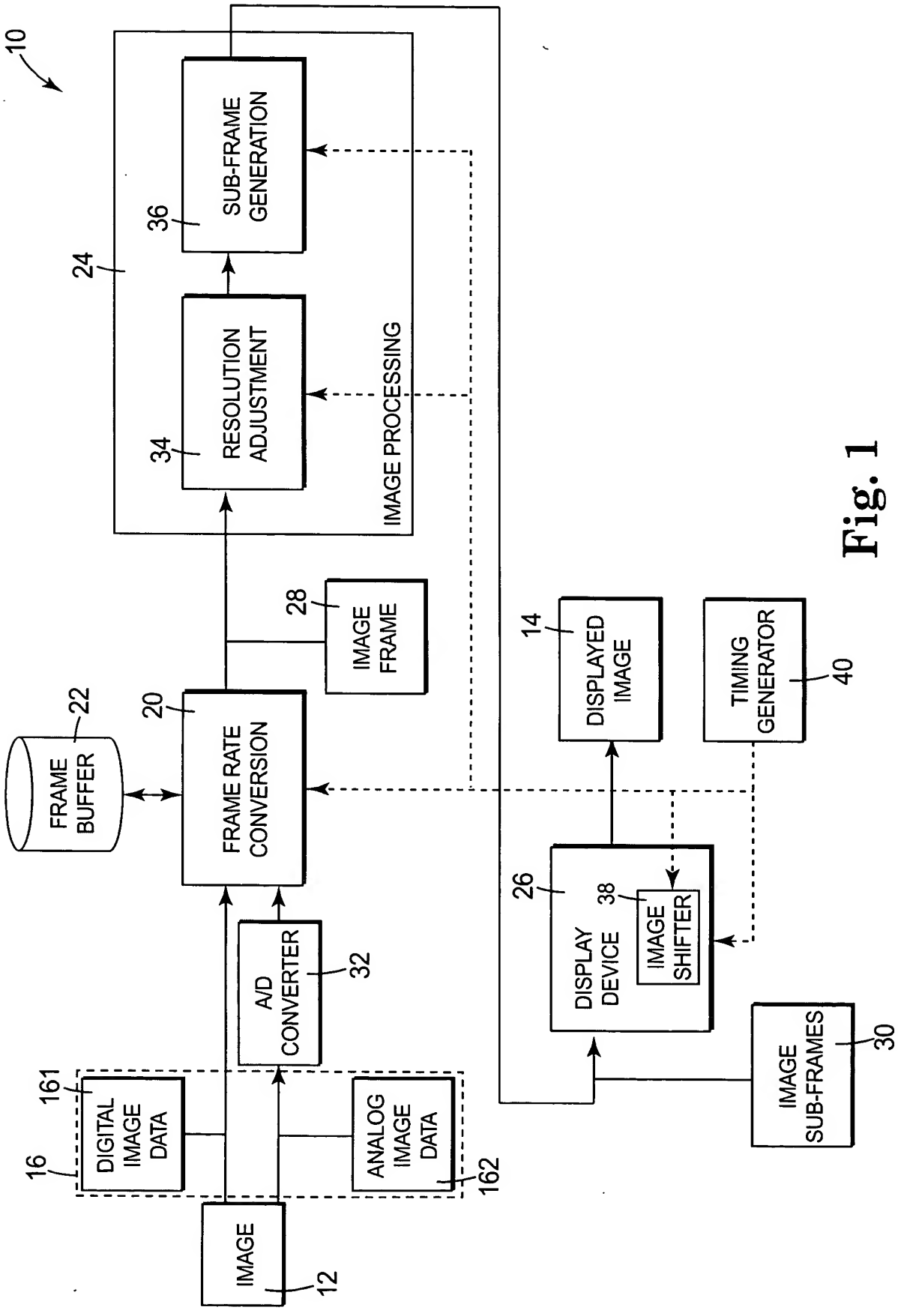

10
24
IMAGE PROCESSING
36
SUB-FRAME GENERATION
34
RESOLUTION ADJUSTMENT
28
IMAGE FRAME
22
FRAME BUFFER
20
FRAME RATE CONVERSION
14
DISPLAYED IMAGE
TIMING GENERATOR
40
26
DISPLAY DEVICE
38
IMAGE SHIFTER
A/D CONVERTER
32
161
DIGITAL IMAGE DATA
16
ANALOG IMAGE DATA
162
IMAGE
12
IMAGE SUB-FRAMES
30

Fig. 1

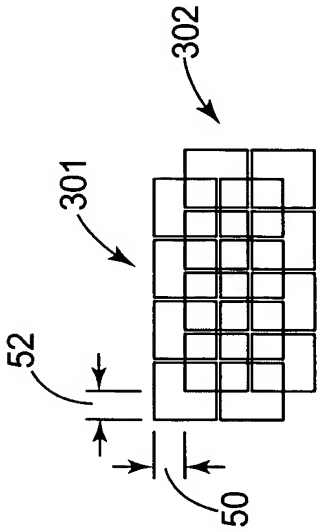


Fig. 2C

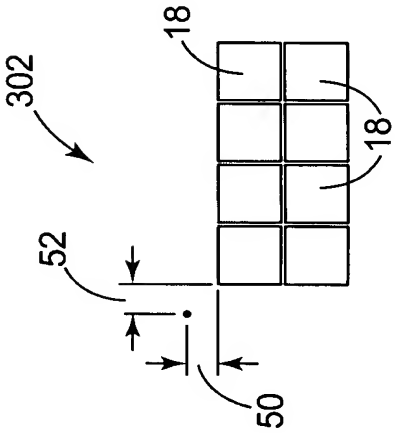


Fig. 2B

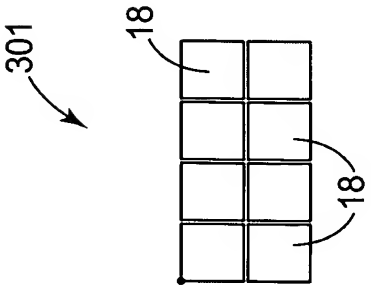


Fig. 2A

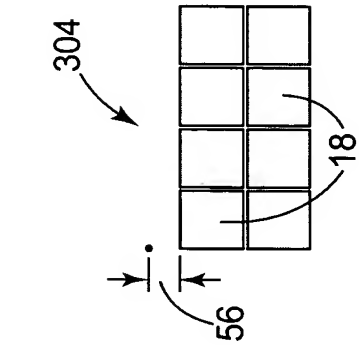


Fig. 3D

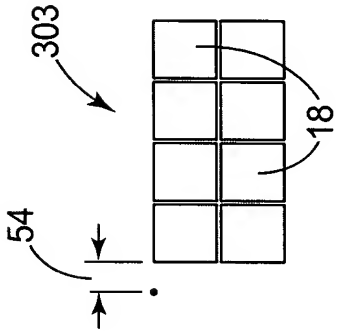


Fig. 3C

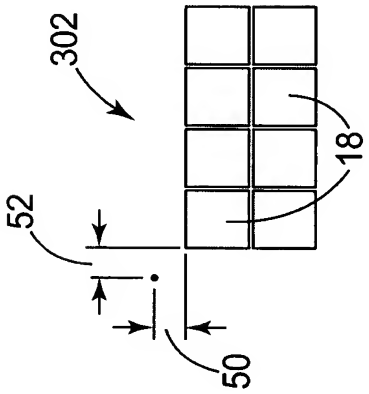


Fig. 3B

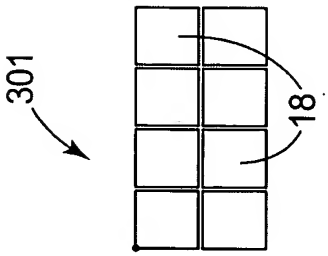


Fig. 3A

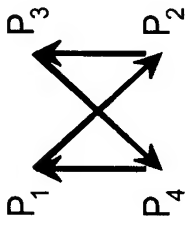


Fig. 3E

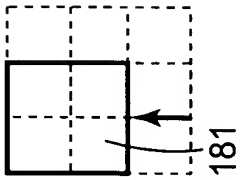


Fig. 4E

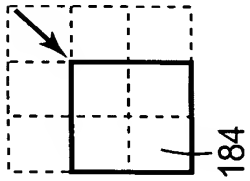


Fig. 4D

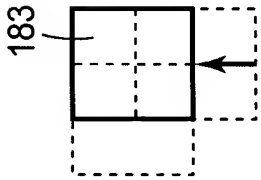


Fig. 4C

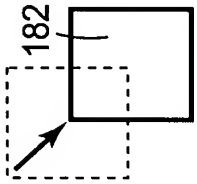


Fig. 4B

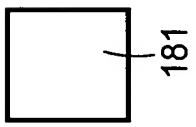


Fig. 4A

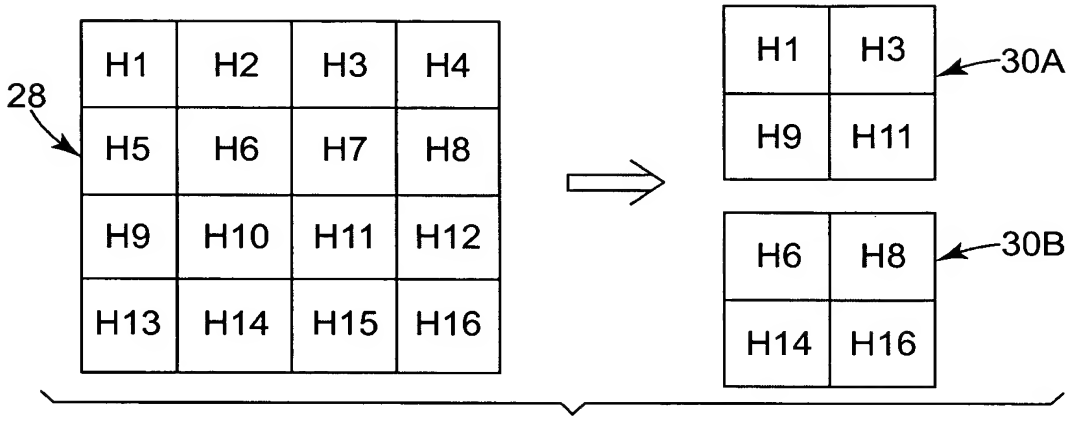


Fig. 5
(NEAREST NEIGHBOR)

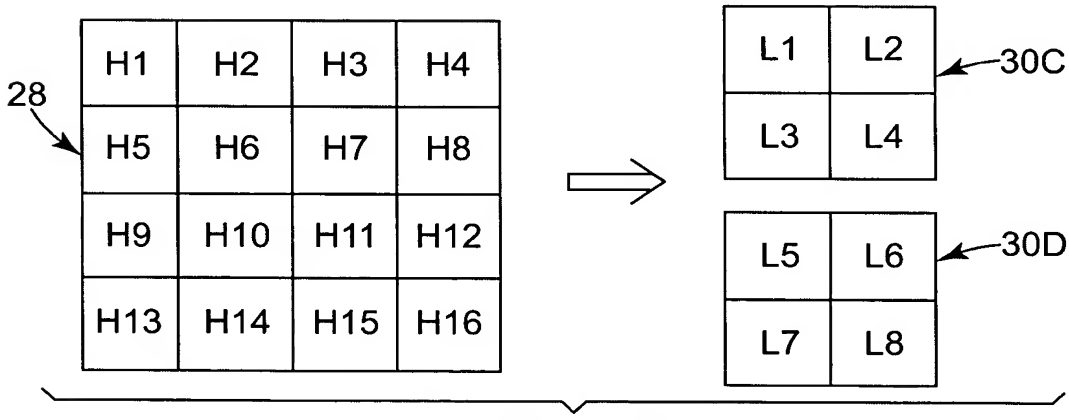


Fig. 6
(BILINEAR)

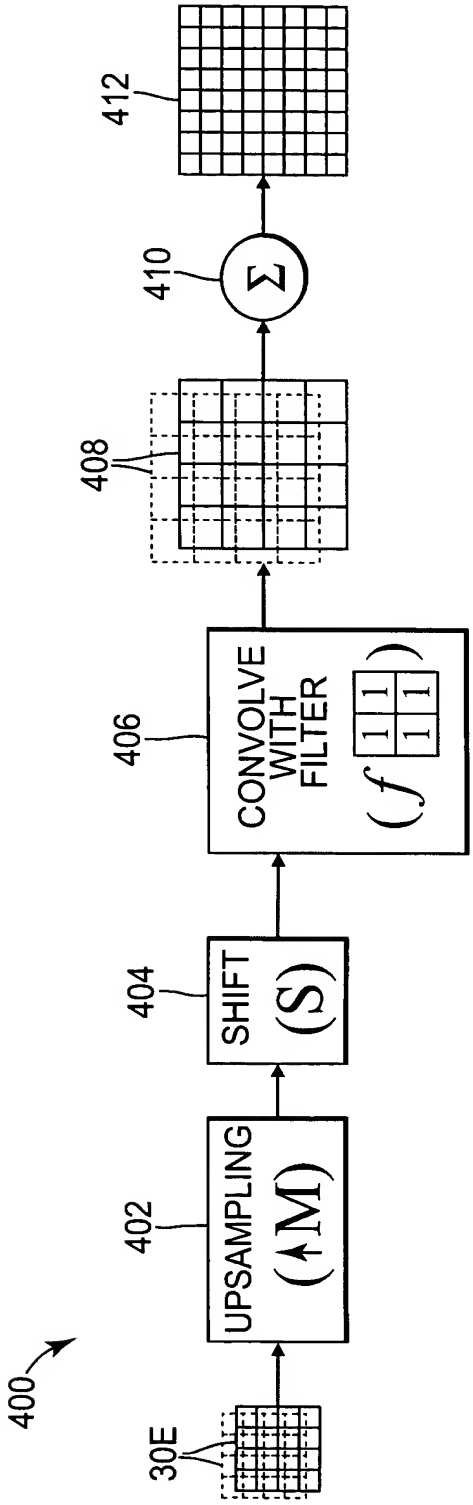

400
30E
UPSAMPLING (↑M)
402
SHIFT (S)
404
CONVOLVE WITH FILTER (f 1 1 1 1)
406
408
Σ
410
412

Fig. 7

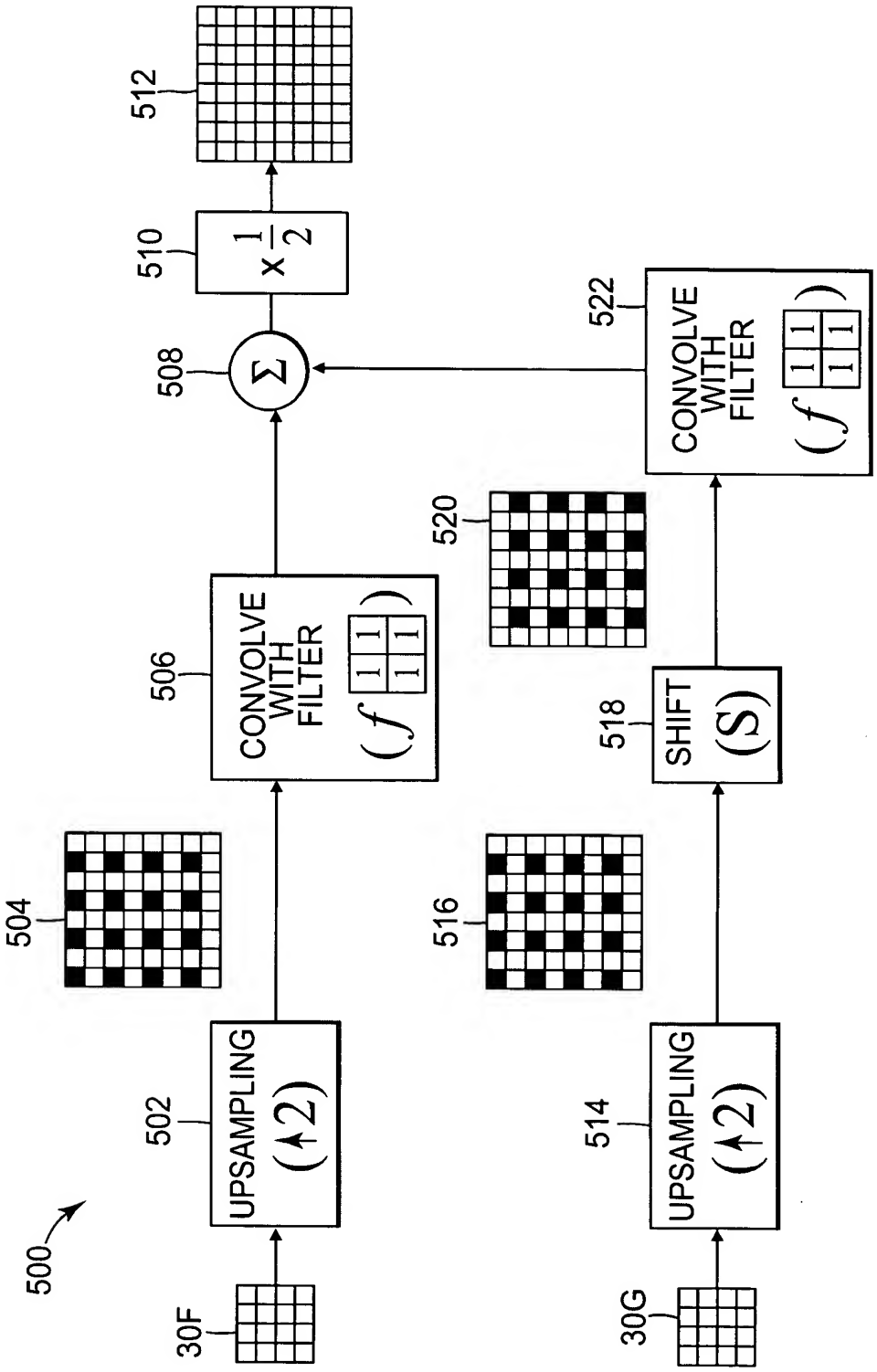

500
30F
30G
UPSAMPLING (↑2)
502
514
UPSAMPLING (↑2)
504
516
CONVOLVE WITH FILTER (f)
506
SHIFT (S)
518
520
CONVOLVE WITH FILTER (f)
522
Σ
508
x 1/2
510
512

Fig. 8

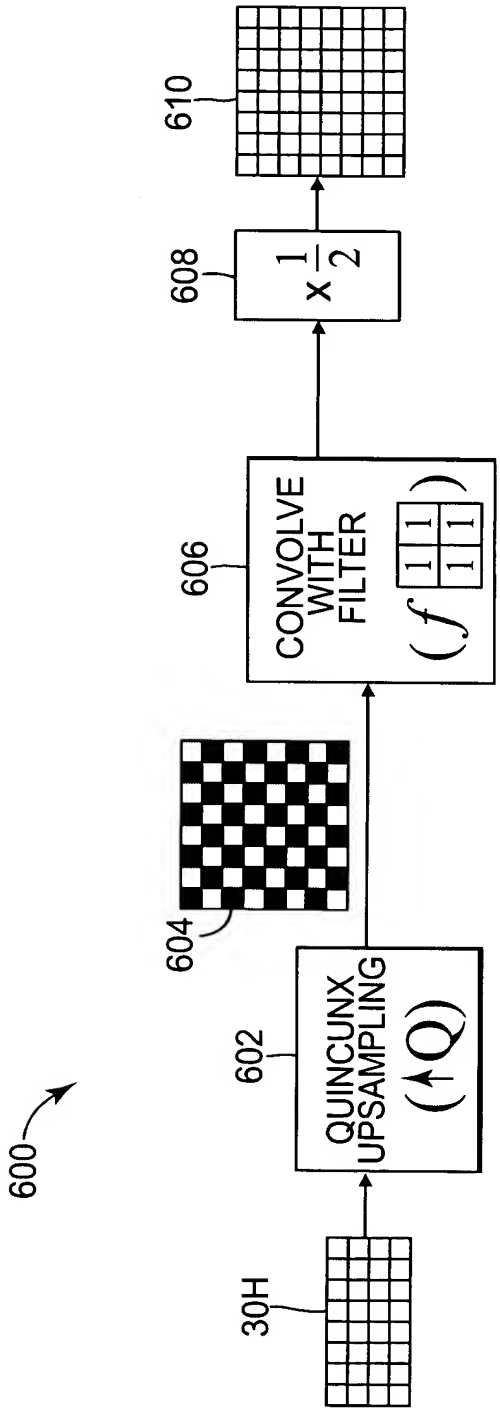

600
30H
602
QUINCUNX UPSAMPLING
(↑Q)
604
606
CONVOLVE WITH FILTER
(f 1 1 1 1)
608
× 1/2
610

Fig. 9

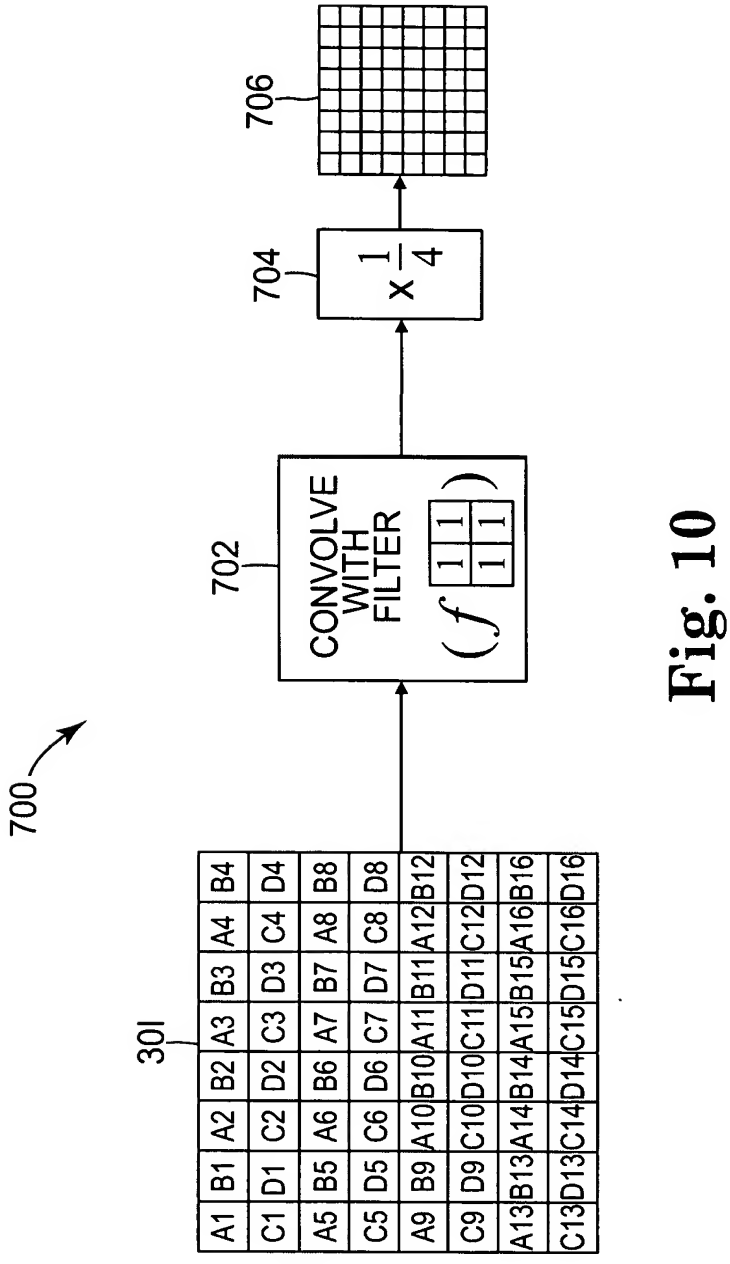

700
301
A1 B1 A2 B2 A3 B3 A4 B4
C1 D1 C2 D2 C3 D3 C4 D4
A5 B5 A6 B6 A7 B7 A8 B8
C5 D5 C6 D6 C7 D7 C8 D8
A9 B9 A10 B10 A11 B11 A12 B12
C9 D9 C10 D10 C11 D11 C12 D12
A13 B13 A14 B14 A15 B15 A16 B16
C13 D13 C14 D14 C15 D15 C16 D16
702
CONVOLVE WITH FILTER
(f 1 1 1 1)
704
x 1/4
706

Fig. 10

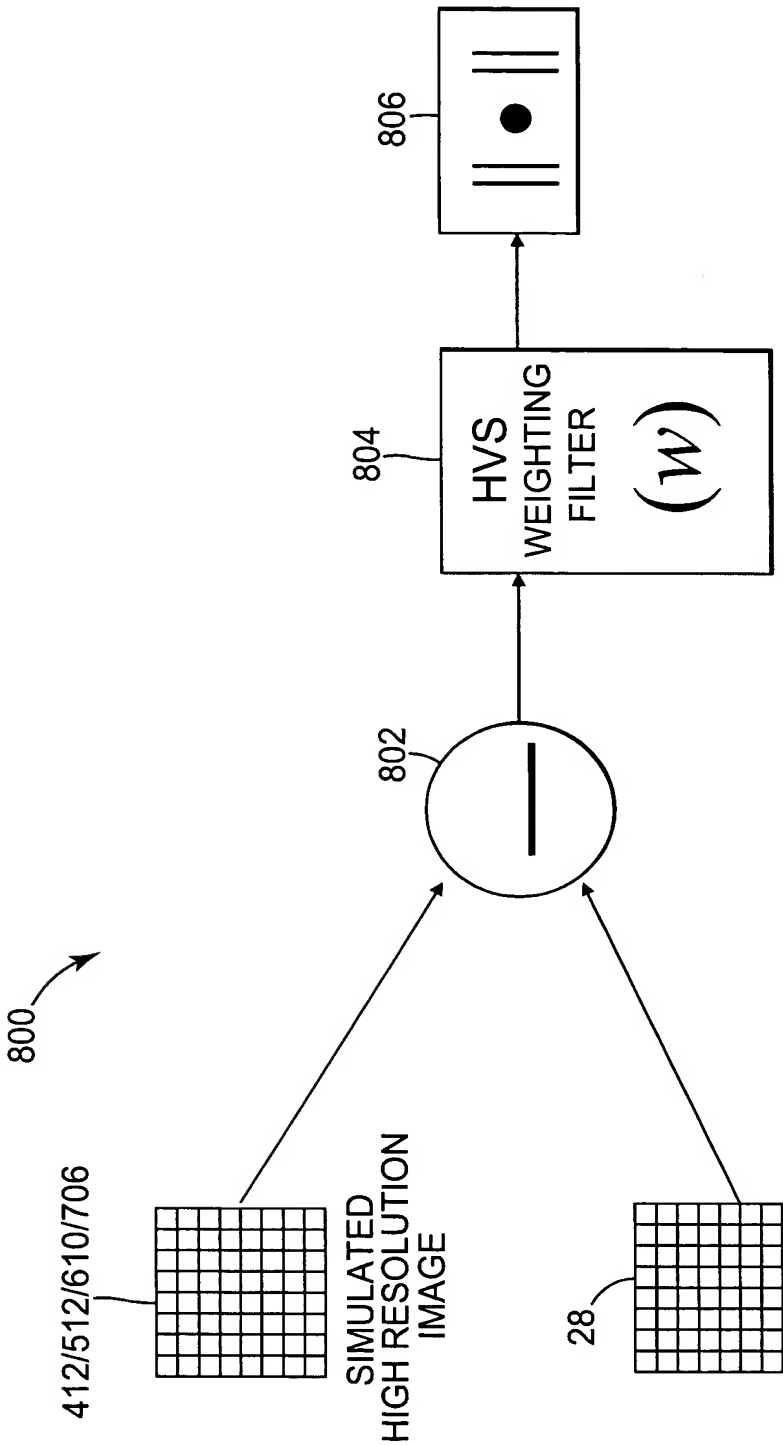

800
412/512/610/706
SIMULATED HIGH RESOLUTION IMAGE
28
DESIRED HIGH RESOLUTION IMAGE
802
804
HVS WEIGHTING FILTER
(W)
806

Fig. 11

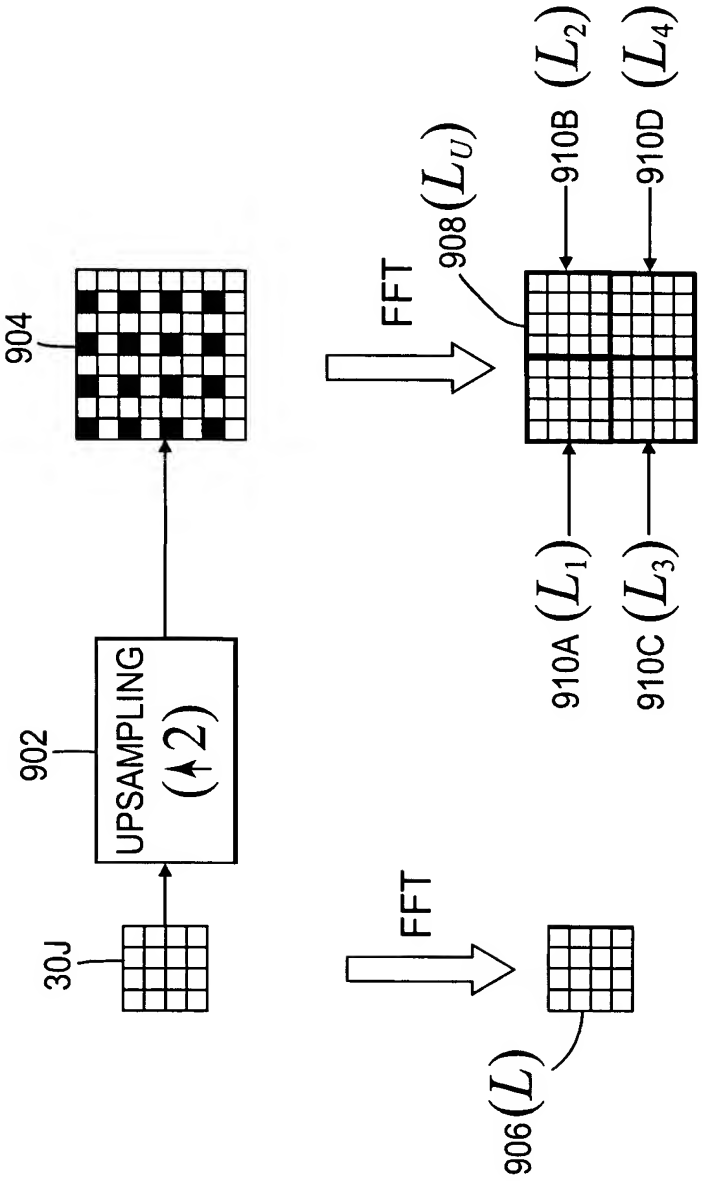
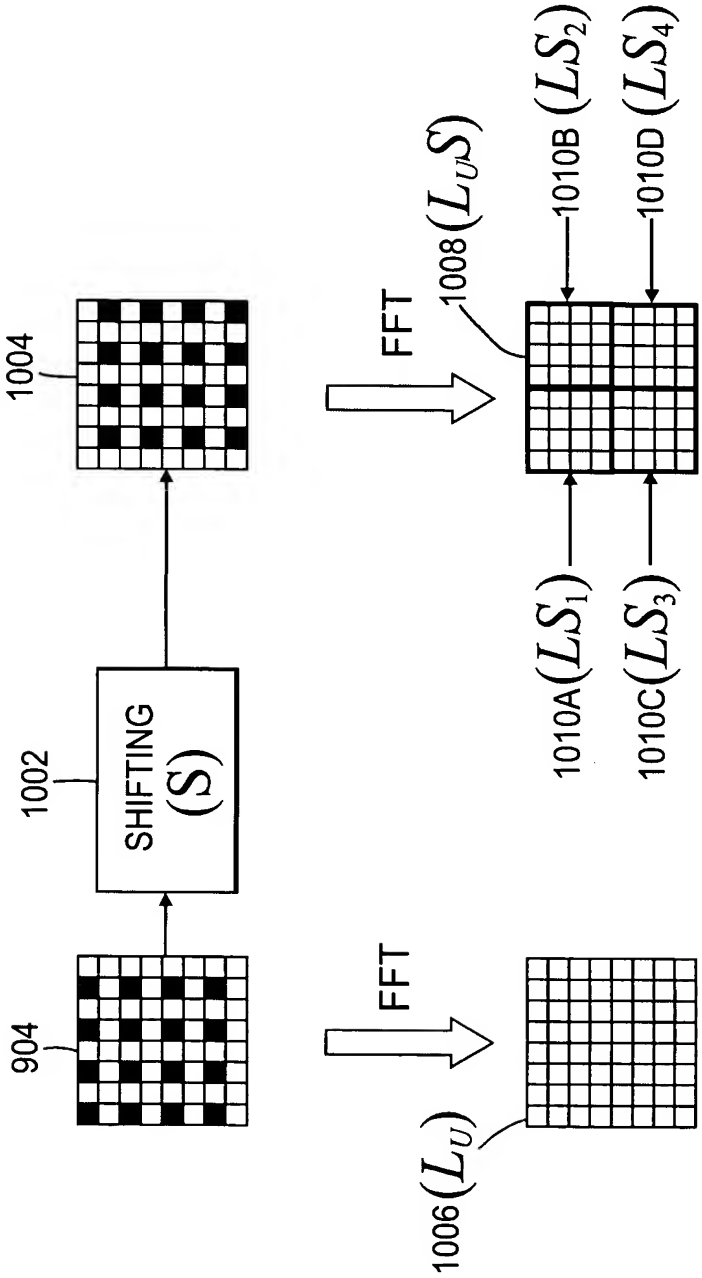

30J
902
UPSAMPLING
(↑2)
904
FFT
906 (L)
FFT
908 (L_U)
910A (L_1)
910B (L_2)
910C (L_3)
910D (L_4)
L_1 = L_2 = L_3 = L_4 = L

Fig. 12



$$L_US = W \cdot L_U$$

Fig. 13

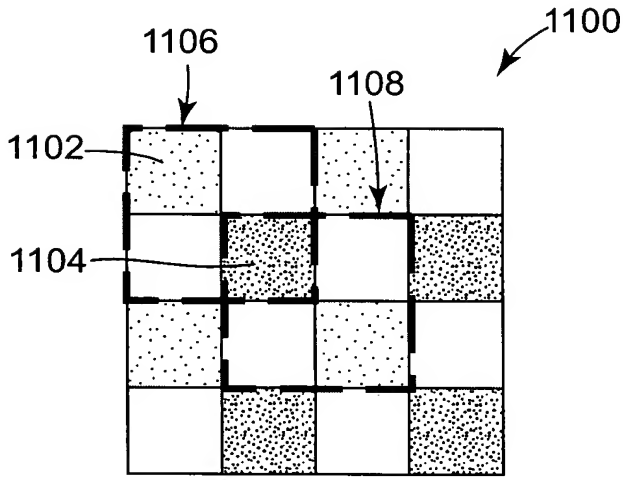


Fig. 14

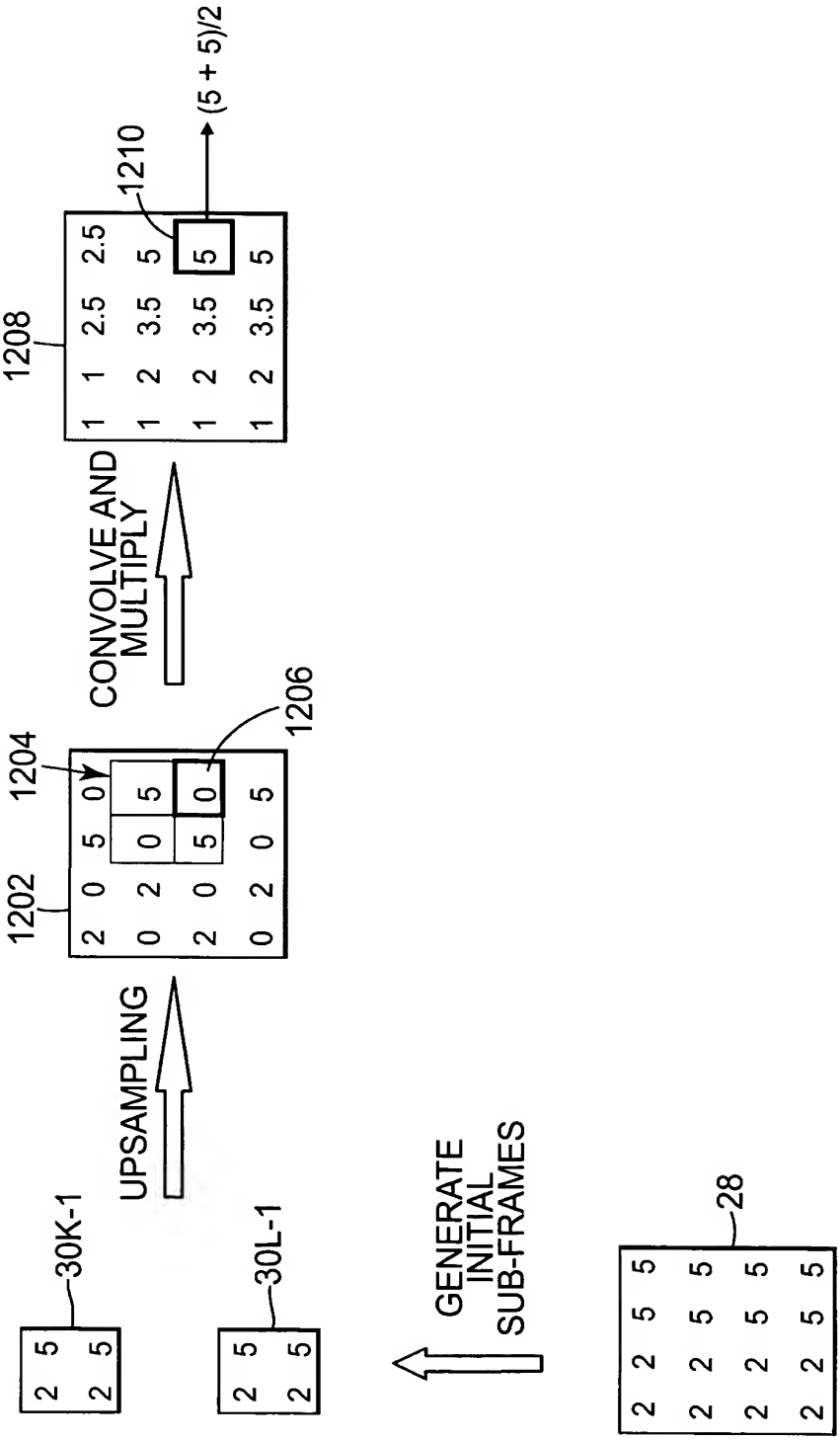

28
2 2 5 5
2 2 5 5
2 2 5 5
2 2 5 5
GENERATE INITIAL SUB-FRAMES
30K-1
2 5
2 5
30L-1
2 5
2 5
UPSAMPLING
1202
2 0 2 0
0 2 0 2
2 0 2 0
0 2 0 2
1204
0 5 0 5
0 5 0 5
1206
CONVOLVE AND MULTIPLY
1208
1 1 2.5 2.5
1 2 3.5 3.5
1 2 3.5 3.5
1 2 3.5 3.5
1210
2.5 5 5
3.5 5 5
3.5 5 5
3.5 5 5
(5 + 5)/2

Fig. 15

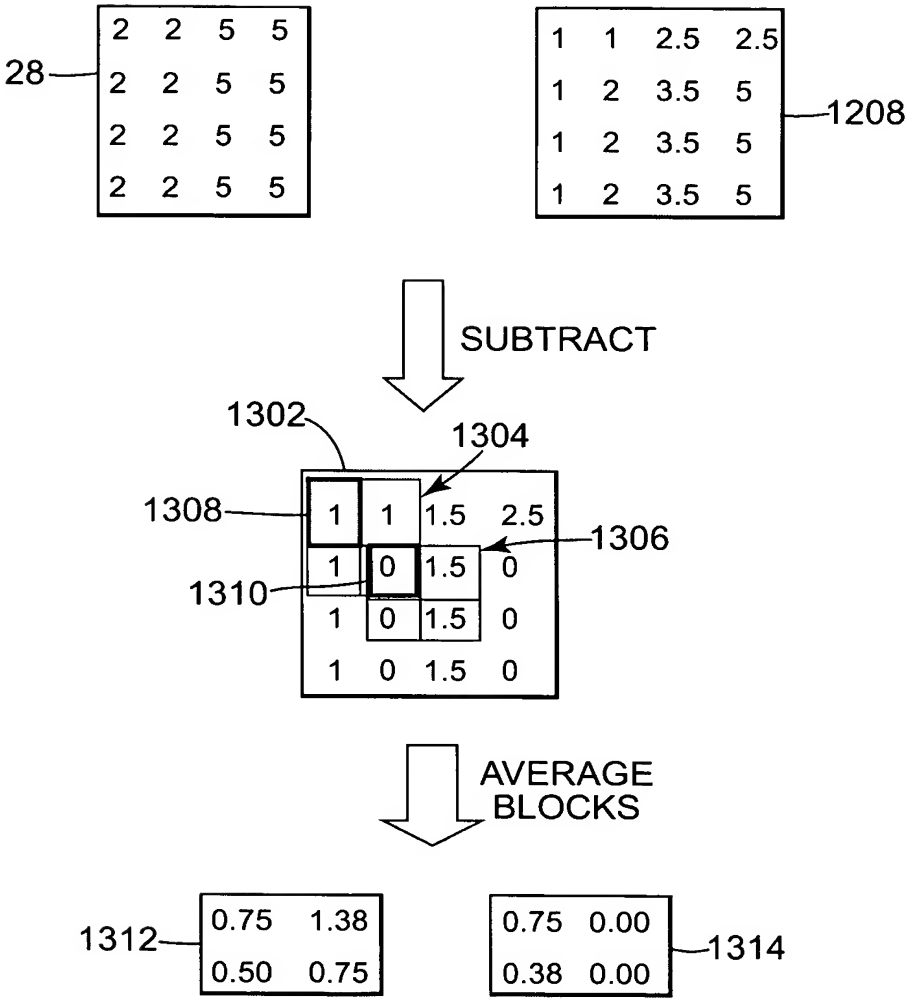

28
2 2 5 5
2 2 5 5
2 2 5 5
2 2 5 5
1 1 2.5 2.5
1 2 3.5 5
1 2 3.5 5
1 2 3.5 5
1208
SUBTRACT
1302
1304
1308
1306
1310
1 1 1.5 2.5
1 0 1.5 0
1 0 1.5 0
1 0 1.5 0
AVERAGE BLOCKS
1312
0.75 1.38
0.50 0.75
0.75 0.00
0.38 0.00
1314

Fig. 16

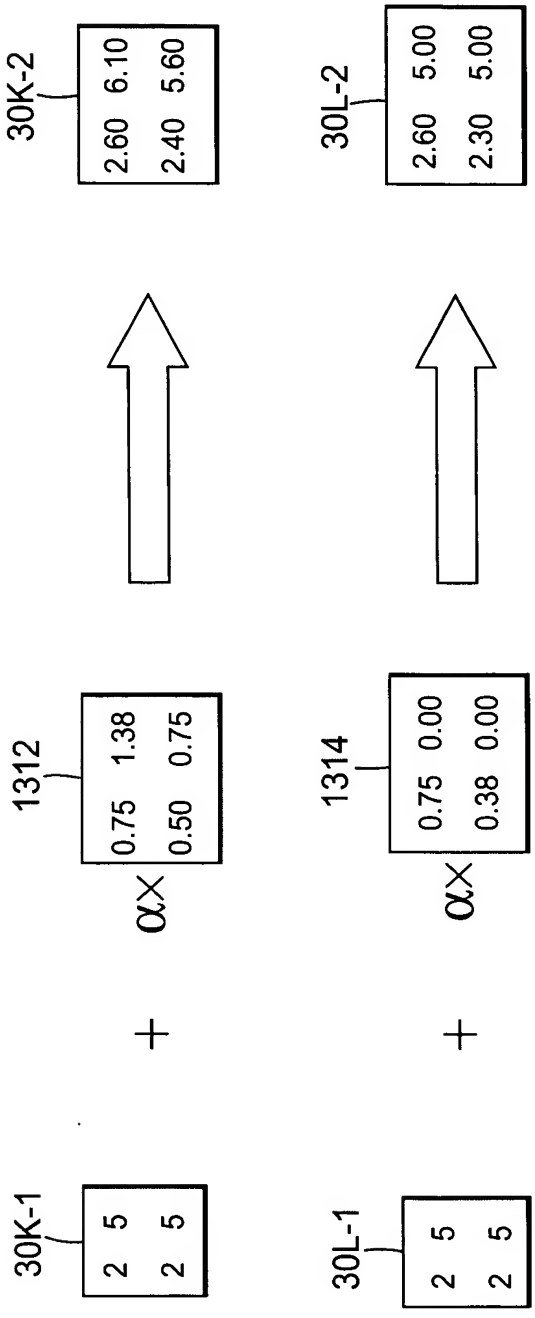

30K-2
2.60 6.10
2.40 5.60
30L-2
2.60 5.00
2.30 5.00
1312
0.75 1.38
0.50 0.75
αX
1314
0.75 0.00
0.38 0.00
αX
α = 0.8
+
+
30K-1
2 5
2 5
30L-1
2 5
2 5

Fig. 17

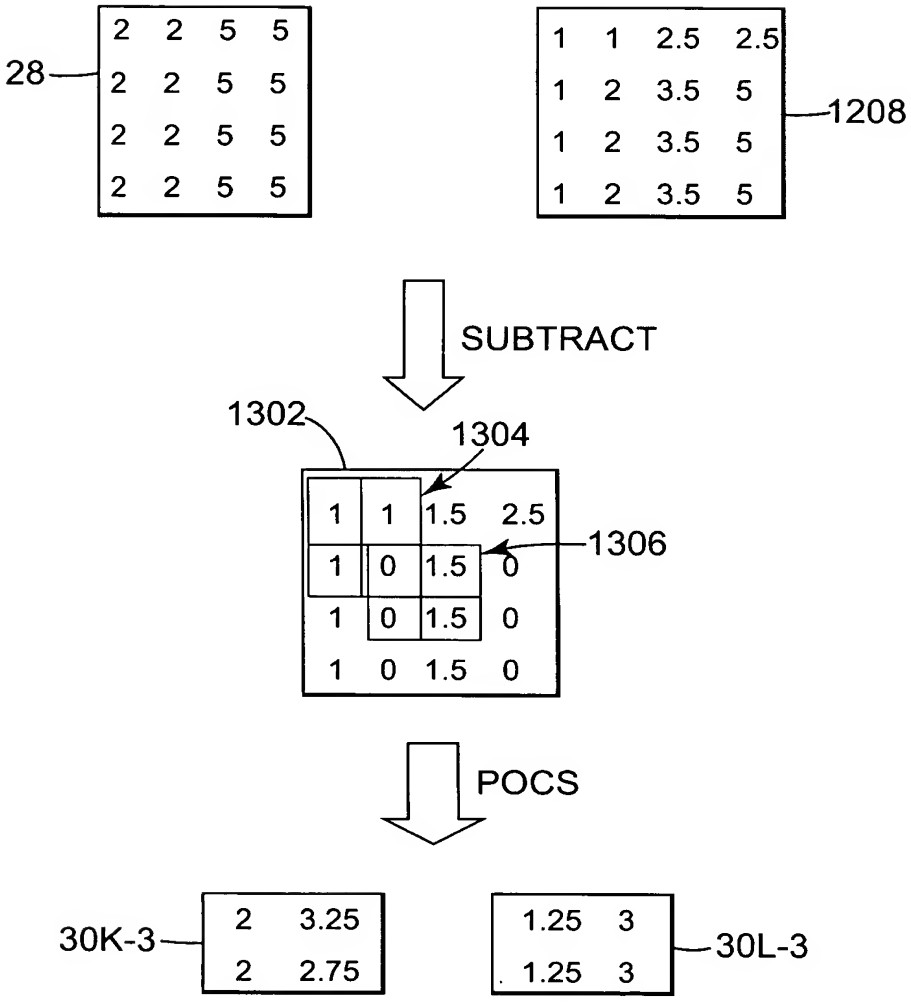

28
2 2 5 5
2 2 5 5
2 2 5 5
2 2 5 5
1 1 2.5 2.5
1 2 3.5 5
1 2 3.5 5
1 2 3.5 5
1208
SUBTRACT
1302
1304
1 1 1.5 2.5
1 0 1.5 0
1 0 1.5 0
1 0 1.5 0
1306
POCS
30K-3
2 3.25
2 2.75
1.25 3
1.25 3
30L-3

Fig. 18

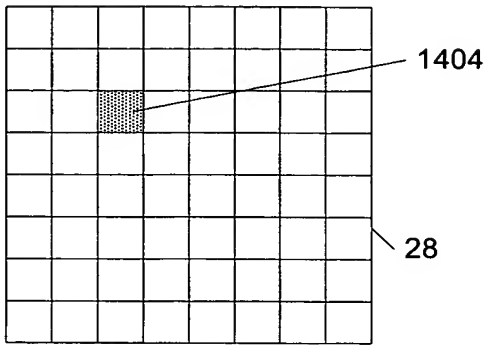


Fig. 19A

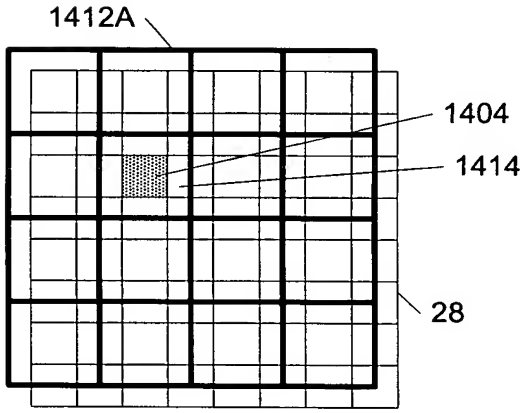


Fig. 19B

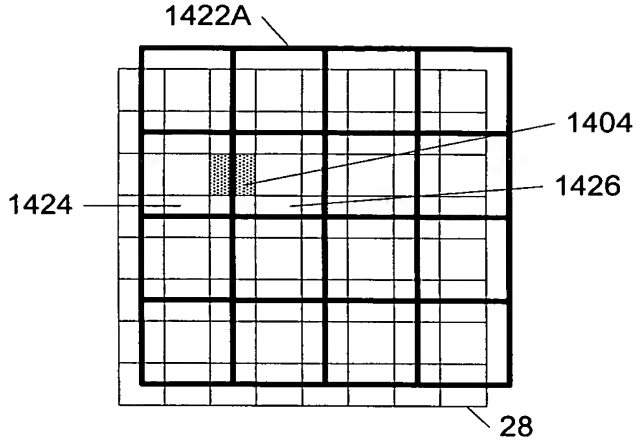


Fig. 19C

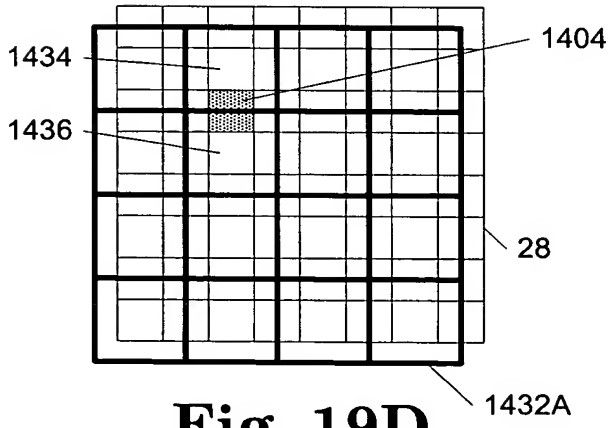


Fig. 19D

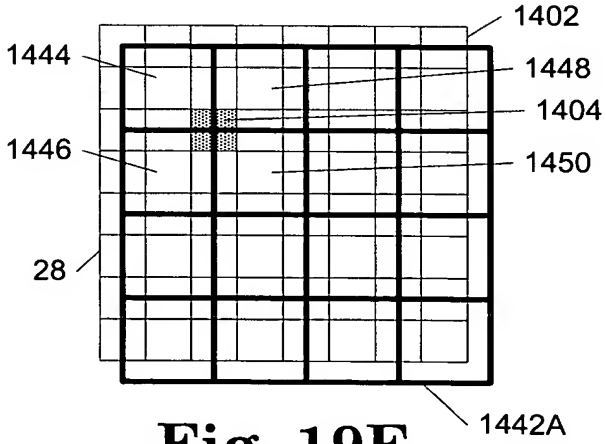


Fig. 19E

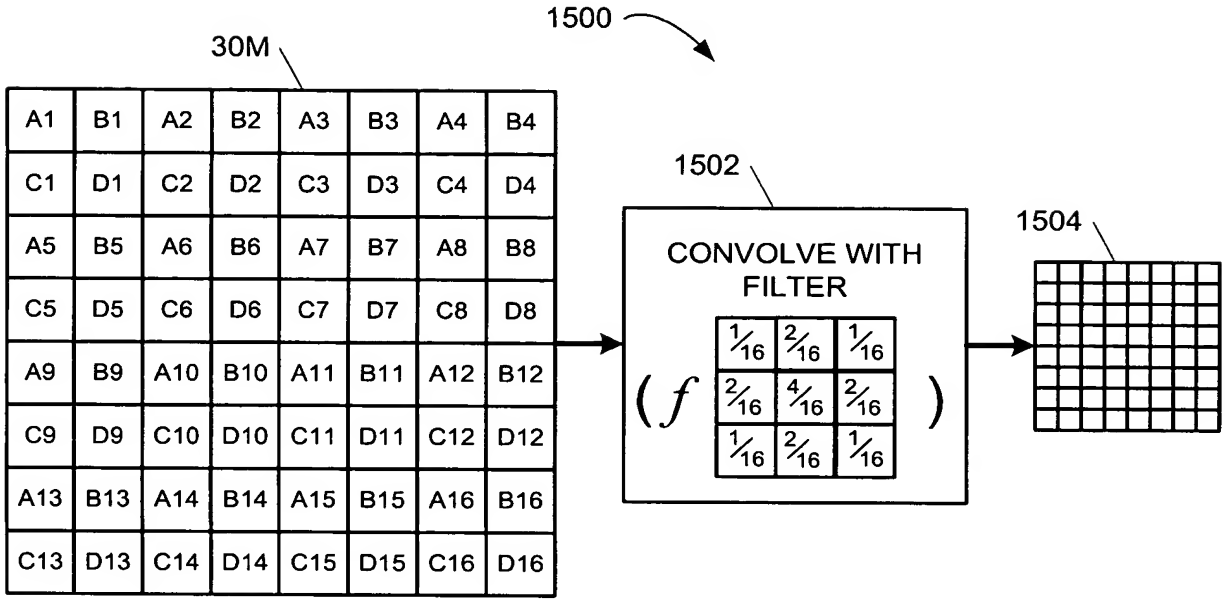

1500
30M
A1 B1 A2 B2 A3 B3 A4 B4
C1 D1 C2 D2 C3 D3 C4 D4
A5 B5 A6 B6 A7 B7 A8 B8
C5 D5 C6 D6 C7 D7 C8 D8
A9 B9 A10 B10 A11 B11 A12 B12
C9 D9 C10 D10 C11 D11 C12 D12
A13 B13 A14 B14 A15 B15 A16 B16
C13 D13 C14 D14 C15 D15 C16 D16
1502
CONVOLVE WITH FILTER
(f 1/16 2/16 1/16 2/16 4/16 2/16 1/16 2/16 1/16)
1504

Fig. 20

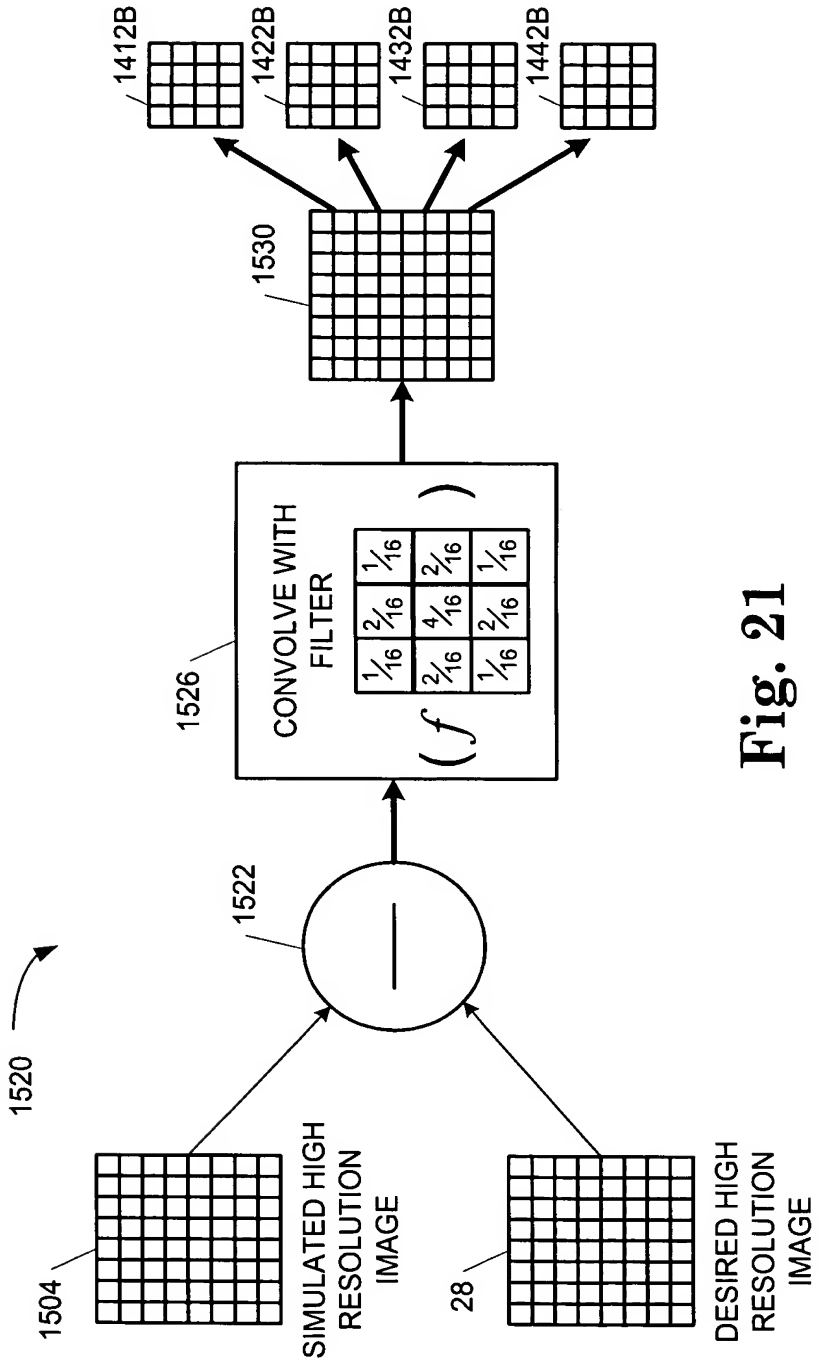

1412B
1422B
1432B
1442B
1530
CONVOLVE WITH FILTER
1/16 2/16 1/16
2/16 4/16 2/16
1/16 2/16 1/16
1526
1522
1520
1504
SIMULATED HIGH RESOLUTION IMAGE
28
DESIRED HIGH RESOLUTION IMAGE

Fig. 21

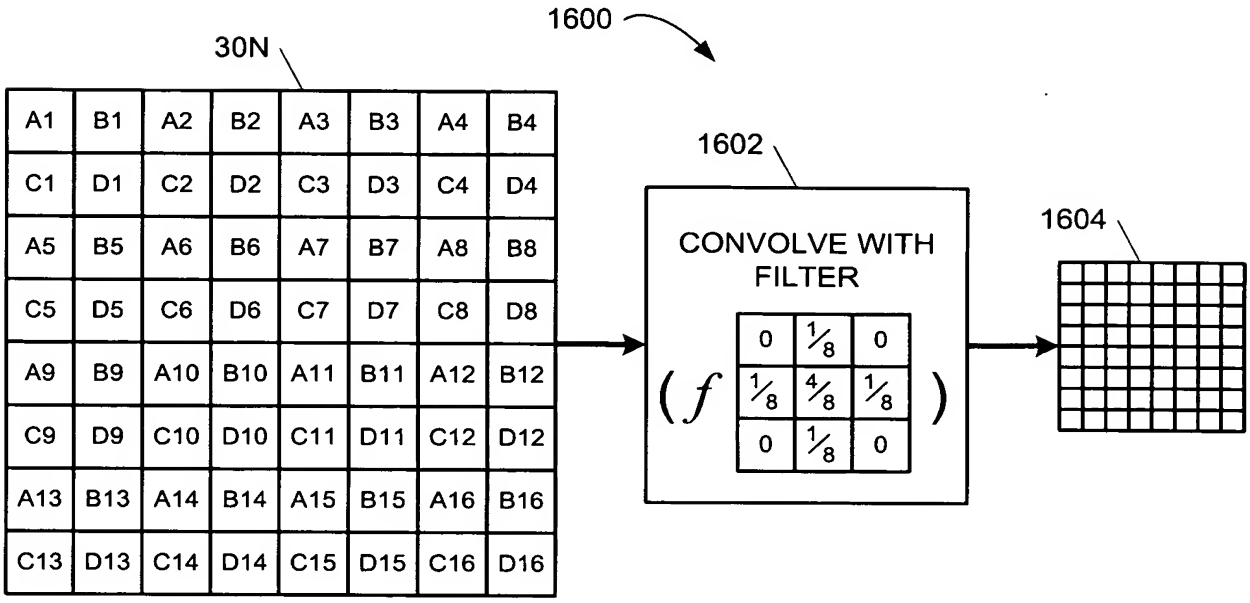

1600
30N
A1 B1 A2 B2 A3 B3 A4 B4
C1 D1 C2 D2 C3 D3 C4 D4
A5 B5 A6 B6 A7 B7 A8 B8
C5 D5 C6 D6 C7 D7 C8 D8
A9 B9 A10 B10 A11 B11 A12 B12
C9 D9 C10 D10 C11 D11 C12 D12
A13 B13 A14 B14 A15 B15 A16 B16
C13 D13 C14 D14 C15 D15 C16 D16
1602
CONVOLVE WITH FILTER
(f 0 1/8 0 1/8 4/8 1/8 0 1/8 0)
1604

Fig. 22

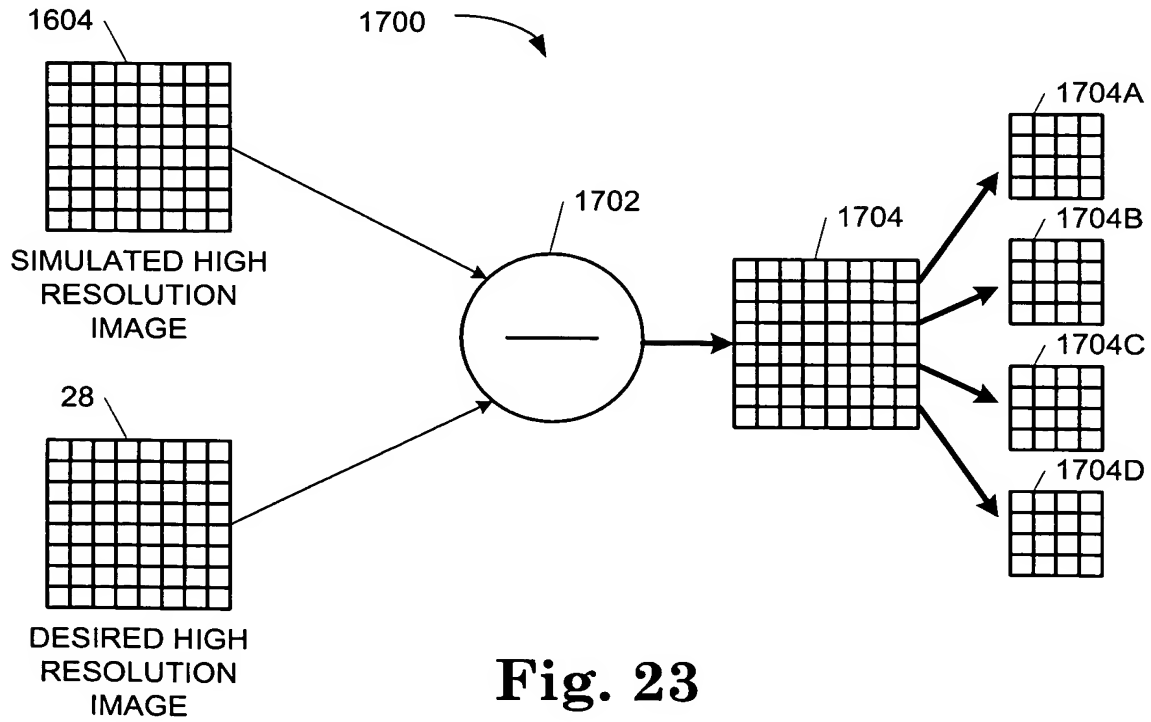

1604
1700
SIMULATED HIGH RESOLUTION IMAGE
28
DESIRED HIGH RESOLUTION IMAGE
1702
1704
1704A
1704B
1704C
1704D

Fig. 23

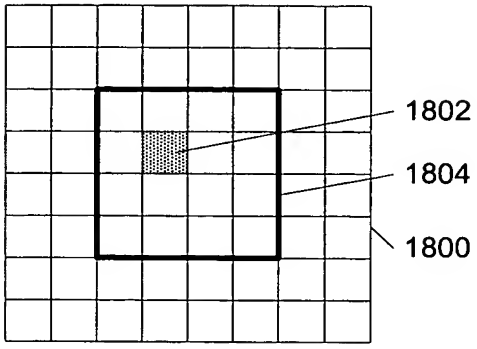


Fig. 24A

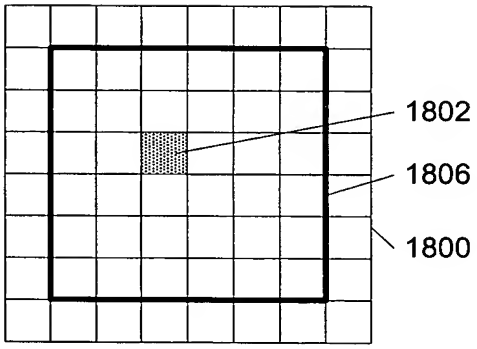


Fig. 24B

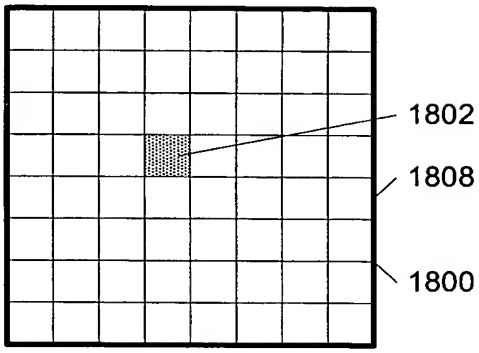


Fig. 24C

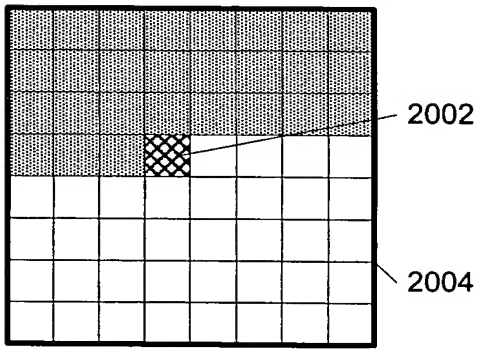


Fig. 26

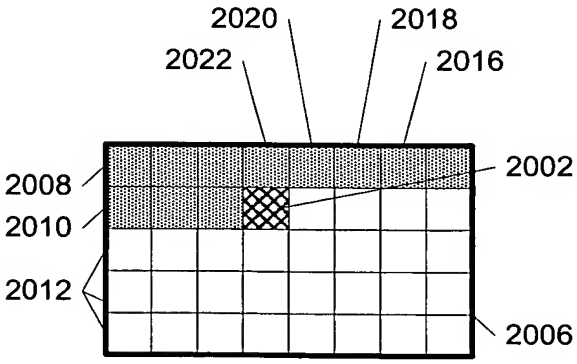


Fig. 27

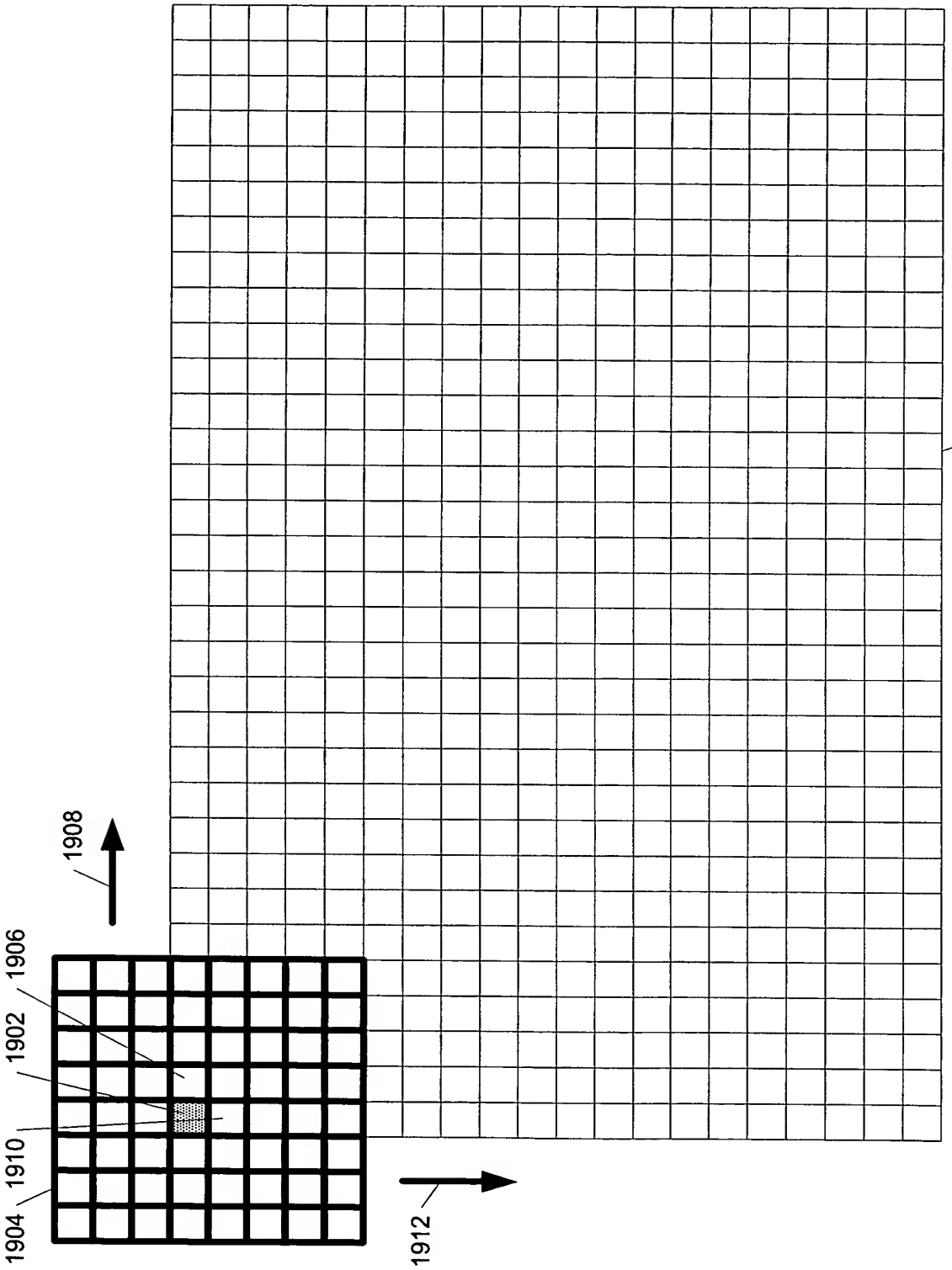


Fig. 25

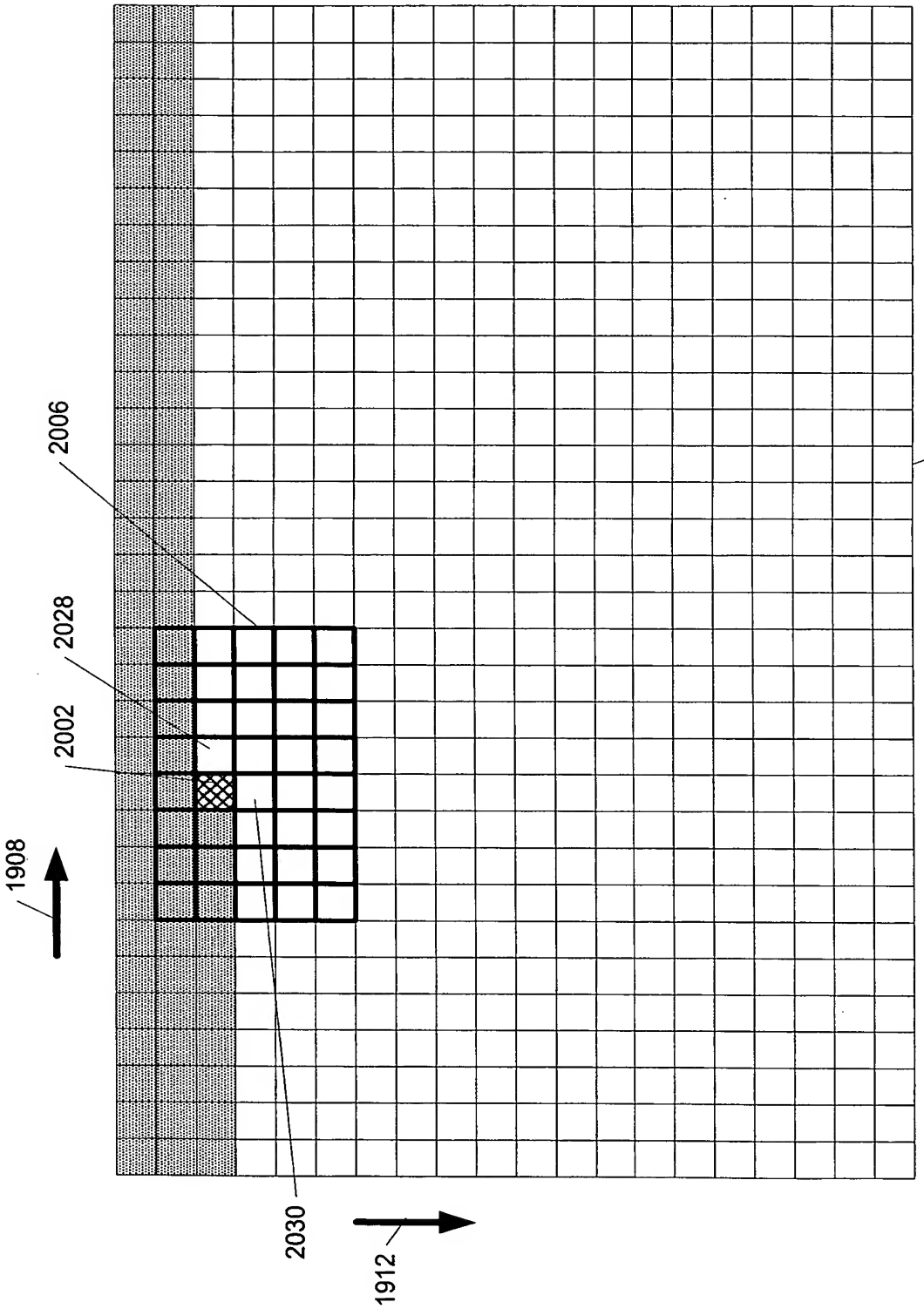


Fig. 28

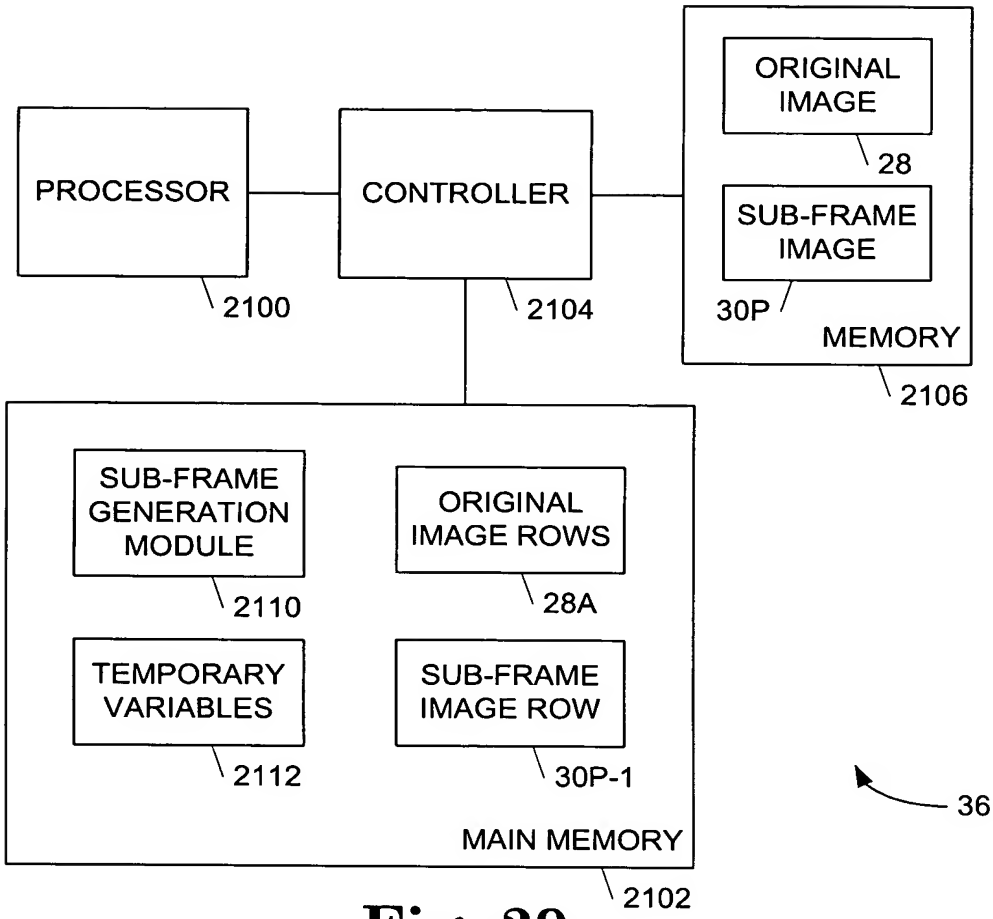


Fig. 29

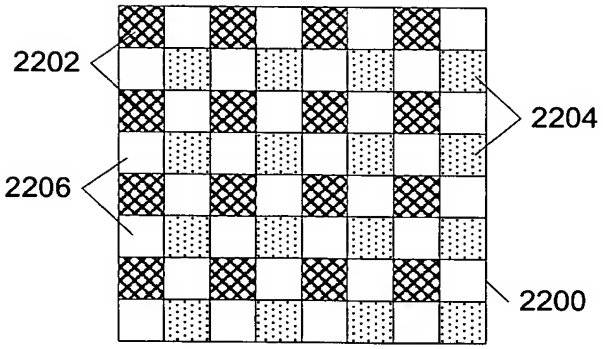


Fig. 30

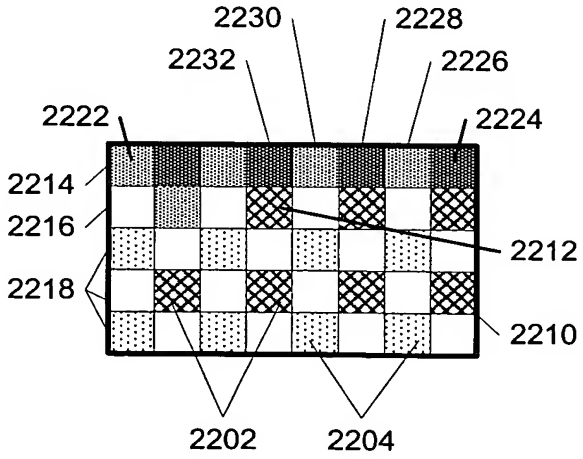


Fig. 31

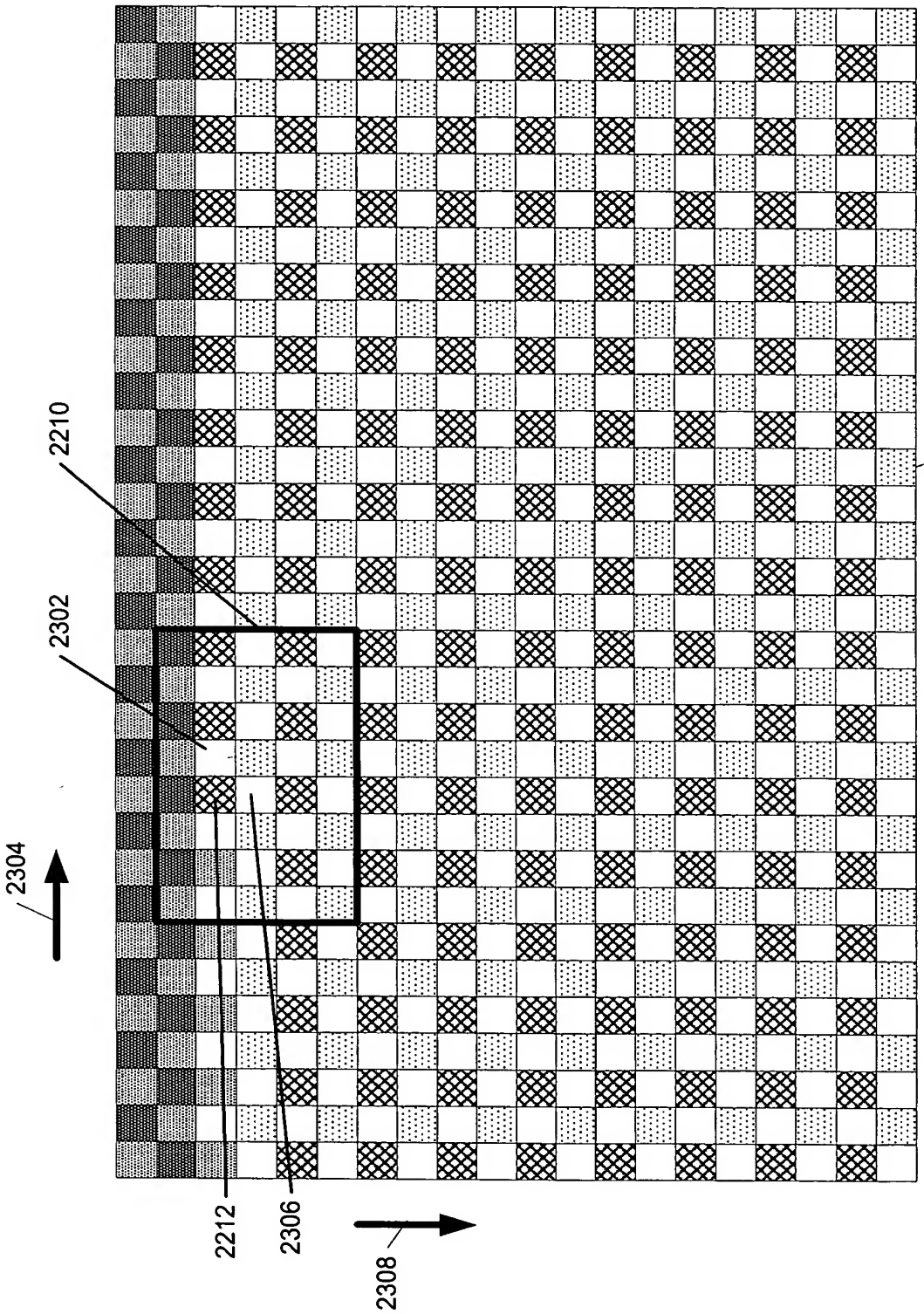


Fig. 32